

- 29,376. *Sebastodes auriculatus* (Girard) J. & G. San Martin Island.  
 29,361. *Sebastodes serriceps* J. & G. San Martin Island.  
 29,374. *Heterostichus rostratus* Grd. San Martin Island.  
 29,360. *Muraena mordax* Ayres.

INDIANA UNIVERSITY, November 15, 1881.

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ON THE GENERA OF CHITONS.

BY W. H. DALL.

PALÆOZOIC FORMS.

The long delay in preparing the illustrations for the monograph of the *Chitonidæ* by the late Dr. Philip P. Carpenter has been the occasion of several calls from paleontologists for an abstract of the genera adopted in his revision of the fossil species. In justice to Dr. Carpenter it seems that the characteristics of the genera should be made public, the material left by him on the Palæozoic species being practically complete and ready for printing. The Mesozoic and Tertiary chitons all belong to groups represented by living species, hence the present abstract relates solely to those of earlier date. The groups of recent chitons, already reviewed by me in these Proceedings,\* form the subject of the second more condensed abstract herewith.

The first fossil chiton was found by DeFrance in 1802, in the Eocene, and described by Lamarek as *Chiton grignonensis*. It was only in 1834 that a second species, *C. antiquus* Conrad, was obtained, on this occasion from the Alabama Tertiary.

The first palæozoic chitons were found in the Carboniferous rocks of Tournay, in 1836, but they were not described until 1839. Since then numerous others have been brought together and described by various authors, as well as a number of organic remains not belonging to the *Chitonidæ* which have wrongly been referred to the group. Dr. Carpenter expended a large amount of time and money in examining the typical specimens in American and European museums, making several journeys for the purpose. His opinions, therefore, are entitled to great weight. Some time before his death, at his request, we went over the ground together, specimens and figures in hand, and the opinion then formed that his work is worthy of great respect, and, so far as facts are concerned, of entire confidence, has not been changed by my subsequent study of his incomplete manuscripts.

An excellent digest of the history of fossil chitons to date of publication was given by De Koninck in 1857,† which was translated for the Annals and Magazine of Natural History, of August, 1860, by W. H. Baily.

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\*Vol. i, pp. 281-344, 1878.

†Bull. Acad. Roy. des Sciences de Belgique, 1857.

The characters for the groups herein described are due to Dr. Carpenter, and are given mostly in his own words. It will be observed that the groups named by others are restricted by him, by elimination of incongruous material included with the original types.

#### HELMINTHOCHITON Salter.

*Helminthochiton* Salter (pars) § 1, Proc. Geol. Soc., 1846, pp. 49, 51, 52, fig. 6 (§§ 2, 3, and figs. 2, 3, exclus.).

Lorica leptoidea, elongata, regularis; mucro ischnoideus; valvæ terminales haud sinuatae; apophyses? (ignotæ).

*Helminthochiton* may be described as a greatly lengthened chitonous animal with the valves thin and angular, and perhaps without apophyses, though the negative evidence is not sufficient to establish so remarkable a departure from the type of the class in general. It differs from *Gryphochiton* in having the terminal valves regular, not sinuate, and in having a regular subcentral Ischnoid mucro instead of the *Gryphax*-like beak characteristic of the second section. It may be regarded as a Leptoid *Ischnoplax* with the valves thrown forward.

#### Species.

*Helminthochiton Griffithi* Salter, l. c., pp. 51, 52, fig. 6. Silurian of Ireland. (Type.)

*Helminthochiton priscoides*, Carpenter. Devonian of Vilmar; Schultze. (Mus. Comp. Zoölogy.)

#### GRYPHOCHITON (Gray) Carpenter.

*Gryphochiton* Gray (pars.), P. Z. S., 1847, p. 70; no diagnosis.

Lorica regularis elongata; laminae laterales nullæ, suturales parvæ, a sinu simplici lato separatæ; mucro postice medianus, incurvatus; regio capitis et candæ valde sinuata. Type *G. priscus* Münster.

*Gryphochiton* resembles a *Leptochiton* greatly drawn out and with the terminal valves more sinuated than has been observed in any recent *Chiton*.

#### Species.

*Gryphochiton priscus* Münster, Beitr. zur petr. Kunde, 1, p. 38, fig. 4, 1839. Carboniferous of Tournay.

*Gryphochiton menpiscus* Ryckholt, Bull. Acad. Roy. des Sci. de Bruxelles, 1845, p. 48, no. 4, pl. 2, figs. 5, 6, 7, 8. Carboniferous of Tournay.

*Gryphochiton triangulatum* Carpenter, Ryckholt, l. c., pl. 2, figs. 4, 9, 10. Same locality.

*Gryphochiton nervicanus*, Ryckholt, l. c., p. 47, No. 3, pl. 1, figs. 7, 8, 9, 1845. Same locality.

#### Subgenus CHONECHITON Carpenter.

Lorica leptoidea, valvæ centrales *Gryphochitoni* similes, projectæ; valva postica mucrone postico, infundibuliformi.

This bears the same relation to *Choneplax* which *Loricites* does to *Lorica*, i. e. similarity, except in the absence of laminae of insertion. It may be described as a Leptoid *Choneplax*. In the recent shell the

funnel is formed by the laminae of insertion; as these do not exist in the leptoid section, the funnel is seen in the hollowing of the back of the valve itself.

*Type.*

*Chouechiton (Chiton) viseticola* Ryckholt, l. c., p. 51, no. 6, pl. 3, figs. 10, 11, 1845. Carboniferous of Visé, Belgium.

PRISCOCHITON Billings.

Leptochiton: lamina postica apicali, intus excavata.

*Type.*

*Priscochiton canadensis* Billings, Pal. Fos. Canada, 1865, p. 394, fig. 370. Lower Silurian.

PTEROCHITON Carpenter.

Lorica elongata, leptoidea; valvæ lateraliter excavatæ, projectæ postice acuminatæ; valva postica regularis, mucrone ischnoideo; valva antica (plerumque?) sinuata; apophyses maximæ, sinu lato. Type *C. eburonicus* Ryckholt.

*Species.*

*Pterochiton eburonicus* Ryckholt, Bull. l. c., part ii, p. 53, no. 8; pl. 4, figs. 7, 8,\* 1845. Carboniferous limestone of Visé, Belgium.

*Pterochiton legiacus* Ryckholt, Bull. l. c., p. 52, no. 7, pl. 4, figs. 5, 6, 1845; *Chiton gemmatus* (pars) Koninek, An. Fos. Carb. Belg., p. 323, no. 3, pl. 23, figs. c, d, e (not figs. a, b). Same locality as the preceding.

*Pterochiton gemmatus* (Koninek) Ryckholt, l. c., 1845, p. 59, no. 13, pl. 4, figs. 1, 2, 3 (fig. 4, forsitan exclus.). Same locality as preceding.

*Pterochiton Thomondiensis* Baily, Nat. Hist. Review and Quart. Journ. Sci., July, 1859, pl. 4, f. 2 a-c. Carboniferous limestone, County Limerick, Ireland.

*Pterochiton Sandbergianus* (?) Ryckholt, l. c., p. 62, 1845. Devonian, Vilmar; Schultze. (Mus. Comp. Zoöl.)

?? *Pterochiton Sluscanus* Ryckholt, l. c., p. 5, No. 10. (Non *C. Sluscanus* ejusdem, pl. 4, figs. 7, 8 = *eburonicus*.† Cf. text.)

Subgenus LORICITES Carpenter.

Related to *Helminthochiton* and to the recent *Lorica* as above stated. From the latter it differs in the absence of laminae of insertion.

Type *Chiton concentricus* Koninek, op. cit., 1857.

PROBOLÆUM Carpenter.

Lorica leptoidea, elongata, maxime projecta; valvis centralibus areae centrales ante areas jugales porrectæ; valva antica sinuata, valva postica—? Type *C. corrugatum* Sandberger (pars).

Among recent forms this comes nearest to *Katherina*, but the difference is still extremely great.

\* The figures are wrongly named *C. Sluscanus* on the plate.

† Koninek does not escape this error also.

## Type.

*Chiton corrugatus* Sandberger fr., Verst. Rhein. Schicht. Nassau, p. 238, pl. 26, fig. 22 a, 1856, not figs. 22, 22 b, 22 c, 22 d = fish scales and valves of barnacles, as per typical specimens in Mus. Comp. Zoölogy, etc. Devonian of Vilmar.

## CYMATOCHITON Dall.

Valvis centralibus transversis, antice projectis, satis elevatis, jugo acutiore, lateribus planatis; apophysibus modicis, satis extantibus, valde distantibus; sinu jugali latissimo, incurrente; umbonibus extantibus, margine antico ad jugum valde postice sinuato. Type *C. Loftusianus* King.

This represents a *Leptochiton* with the valves thrown forward. It differs from *Proboleum* in the valves being transverse instead of squared, and in the terminal valves being regular instead of waved. The name *Cymatodus* used in manuscript for this group by Dr. Carpenter is preoccupied by Newberry (1870).

## Species.

*Cymatochiton Loftusianus* King, Annals & Mag. Nat. History, I, vol. 14, p. 382; Kirkby, Proc. Geol. Soc., 1859, p. 607, 611, 615, pl. 16, figs. 31-41. Permian, Tunstall Hill, England.

*Cymatochiton Ryckholtianus* Koninck Mss. Types Mus. Comp. Zoöl. Carboniferous of Visé, Belgium.

? *Cymatochiton tornaticola*\* Ryckholt, l. c., p. 45, pl. 1, figs. 1, 2, 3, 1845. Carboniferous of Tournay.

? *Cymatochiton Scaldeanus*\* Ryckholt, l. c., p. 46, pl. 1, figs. 4, 5, 6, 1845. Same locality.

? *Cymatochiton Howscannus* Kirkby, Quart. Journ. Geol. Soc. 1857, p. 216, pl. 7, figs. 9-13. Permian, Tunstall Hill, England.

This last species is the first undoubted *Chiton* to put on features common to all the recent forms of the family.

Until the full record of his investigations is published, the amount of confusion as to types, discrepancies between figures and specimens, and errors of one kind and another discovered by Dr. Carpenter in his examination of the original types of many of the species can hardly be imagined. The synonymy is also necessarily left until the complete paper shall be printed. Meanwhile the student is warned that the citations herein actually made are the only ones which are guaranteed to relate to the species named, though there may be, and in most cases are, others which might be cited. The preceding (with synonyms) number all the Palæozoic chitons actually determined to be such up to 1873.

In the course of the investigation the following species have been found not to be chitons or chitonoid. They belong variously to fish scales, barnacle (*Turrilepas*) valves, ostracod crustacea, and some to undetermined organisms.

\* Doubt attaches to the molluscan nature of these two minute species, which have some crustacean features.

- "*Chiton*" *Grayanus* Koninek, 1857. Upper Silurian.  
 "*Chiton*" *Wrightianus* Koninek, ditto.  
 "*Chitonellus*" *Hancockianus* Kirkby, Proc. Geol. Soc., 1859, pl. 16, figs. 1-13. Permian, England.  
 "*Chiton*" *cordatus* Kirkby, ditto, figs. 24-29.  
 "*Chitonellus*" *distortus* Kirkby, ditto, figs. 28-30.  
 "*Chitonellus*" *antiquus* Howse, Kirkby l. c., figs. 14-23. Permian.  
 "*Chiton*" *cordifer* Koninek, Descr. An. Foss. Terr. Carb. Belg., 1844, p. 324, pl. 22, fig. 5 a, b (teste Ryckholt). Carboniferous of Belgium.  
 "*Chiton*" *corrugatus* Sandberger (pars), p. 238, pl. 26, figs. 22, 22 b, 22 c, 22 d, 1856. Devonian and Lower Devonian of Vilmar and Ehrenbreitstein.  
 "*Chiton*" *sagittalis* Sandberger, l. c., p. 239, pl. 26, figs. 23 a, b. Same locality?  
*Sulcochiton Grayi* Ryckholt, Journal de Conchyl., 1862, p. 279, pl. xii, f. 14. Carboniferous of Visé, Belgium.

ABSTRACT OF ALL THE GENERA.

Order POLYPLACIPHORA.

Section I.—Chitones regulares.

Head and tail plates similarly articulated.

A. LEPTOIDEA.

Insertion plates obsolete or, if present, unslit.

(*Extinct forms.*)

- |                                   |                                  |
|-----------------------------------|----------------------------------|
| 1. <i>Helminthochiton</i> Salter. | 4. <i>Pterochiton</i> Cpr.       |
| 2. <i>Gryphochiton</i> Gray.      | <i>a.?</i> <i>Loricites</i> Cpr. |
| <i>a. Chonechiton</i> Cpr.        | 5. <i>Probolorum</i> Cpr.        |
| 3. <i>Priscochiton</i> Billings.  | 6. <i>Cymatochiton</i> Dall.     |

(*Recent forms.*)

- |                              |                                       |
|------------------------------|---------------------------------------|
| 7. <i>Leptochiton</i> Gray.  | 9. <i>Hemiarthrum</i> Cpr.            |
| <i>a. Deshayesiella</i> Cpr. | 10. <i>Microplax</i> Adams and Angus. |
| 8. <i>Hanleyia</i> Gray.     |                                       |

B. ISCHNOIDEA.

Insertion plates sharp, smooth, fissured; with eaves.

\*No pores on girdle.

- |                                      |                                      |                            |
|--------------------------------------|--------------------------------------|----------------------------|
| 11. <i>Trachydermon</i> Cpr.         | 18. <i>Ischnochiton</i> Gray.        |                            |
| <i>a. Trachyradsia</i> Cpr.          |                                      |                            |
| 12. <i>Callochiton</i> Gray.         |                                      |                            |
| <i>a. Stereochiton</i> Cpr.          |                                      |                            |
| 13. <i>Tonicella</i> Cpr.            |                                      |                            |
| 14. <i>Schizoplax</i> Dall.          |                                      |                            |
| 15. <i>Leptoplax</i> Cpr.            |                                      |                            |
| 16. <i>Chatopleura</i> Shuttleworth. |                                      |                            |
| <i>a. Maugerella</i> Cpr.            |                                      |                            |
| 17. <i>Spongiochiton</i> Cpr.        |                                      |                            |
|                                      |                                      | <i>a. Stenoplax</i> Cpr.   |
|                                      |                                      | <i>b. Stenoradsia</i> Cpr. |
|                                      |                                      | <i>c. Ischnoplax</i> Cpr.  |
|                                      | <i>d. Heterozona</i> Cpr.            |                            |
|                                      | <i>e. Ischnochiton</i> s. s. Cpr.    |                            |
|                                      | <i>f. Ischnoradsia</i> Shuttleworth. |                            |
|                                      | <i>g. Lepidopleurus</i> Cpr.         |                            |
|                                      | <i>h. Lepidoradsia</i> Cpr.          |                            |
|                                      | 19. <i>Callistochiton</i> Cpr.       |                            |

\*\*With girdlepores.

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|------------------------------|------------------------------|
| 20. <i>Callistoplax</i> Cpr. | 23. <i>Ceratozona</i> Dall.  |
| 21. <i>Angasia</i> Cpr.      |                              |
| 22. <i>Newcambia</i> Cpr.    |                              |
|                              | 24. <i>Pallochiton</i> Dall. |

## C. LOPHYROIDEA.

Insertion plates broad, pectinated, projecting backward.

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|---|---|
| 25. <i>Chiton</i> Linné.<br>a. <i>Radsia</i> Gray.    | 27. <i>Endorochiton</i> Shuttleworth.   |
| 26. <i>Tonicia</i> Gray.<br>a. <i>Fannettia</i> Dall. | 28. <i>Craspedochiton</i> Shuttleworth. |

## D. ACANTHOIDEA.

Insertion plates thrown forward.

\* Plates broad, pectinated (*A. lophyroidca*).

- 29.
- Sclerochiton*
- Cpr.

\*\* Plates sharp, grooved outside (*A. typica*).

- |   |  |
|---|--|
| 30. <i>Acanthopleura</i> Guilding.<br>a. <i>Lucilina</i> Dall.<br>b. <i>Corephium</i> Gray.<br>c. <i>Francisia</i> Cpr. |  |
|---|--|

\*\*\* Plates sharp, smooth (*A. ischnoidea*.)

- |  |   |
|--|---|
| 31. <i>Dinoplax</i> Cpr.                                 | 33. <i>Nuttallina</i> Cpr.                                      |
| 32. <i>Middendorfia</i> Cpr.<br>a. <i>Beanella</i> Dall. | 34. <i>Arthuria</i> Cpr.<br>35. <i>Phacellopleura</i> Guilding. |

## Section II.—Chitones irregulares.

Tail plate abnormal or with a sinus behind.

## E. SCHIZOIDEA.

Tail valve fissured.

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|--|-------------------------------|
| 36. <i>Lorica</i> H. and A. Adams.<br>a. <i>Aulacochiton</i> (Shuttleworth) Cpr. | 37. <i>Schizochiton</i> Gray. |
|--|-------------------------------|

## F. PLACIPHOROIDEA.

Tail valve unslit, internally ridged, mucro nearly terminal.

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|--------------------------------|---|
| 38. <i>Enoplochiton</i> Gray.  | 40. <i>Placiphora</i> Gray.<br>a. <i>Fremblya</i> H. Adams.       |
| 39. <i>Ornithochiton</i> Gray. | b. <i>Euplaciphora</i> Shuttleworth.<br>c. <i>Guildingia</i> Cpr. |

## G. MOPALOIDEA.

Tail valve with posterior sinus and one slit on each side.

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|--|---|
| 41. <i>Mopalia</i> Gray.<br>a. <i>Placiphorella</i> Cpr. | 43. <i>Acanthochiton</i> (Leach) Herrm.<br>a. <i>Macandrellus</i> Cpr.<br>b. <i>Stectoplax</i> Cpr. |
| 42. <i>Katherina</i> Gray.                               | 44. <i>Notoplax</i> H. Adams.   |



H. CRYPTOIDEA.

With double sutural laminae.

- |  |   |   |
|--|---|---|
| <p>45. <i>Cryptoconchus</i> Blainville.<br/>                 46. <i>Amicula</i> Gray.<br/>                     <i>a. Amicula</i> s. s. Dall.<br/>                     <i>b. Chlamydochiton</i> Dall.</p> | } | <p>47. <i>Cryptochiton</i> Gray and Middendorf.</p> |
|--|---|---|

I. CHITONELLOIDEA.

Tail plate funnel-shaped. Laminae thrown forward.

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|--|---|--|
| <p>48. <i>Chitonellus</i> Blainville.<br/>                     <i>a. Chitonoplax</i> Gray.</p> | } | <p>49. <i>Choneplax</i> Cpr.<br/>                     <i>a. Chitoniscus</i> Cpr.</p> |
|--|---|--|

It is hardly necessary to observe that the names here ascribed to Gray, Shuttleworth, and other older writers are more or less restricted so as to make them natural assemblages, which most of them originally were not. The subdivisions under similar names to be found in Adams' Genera of Recent Mollusca and Chénu's Manual are nearly all heterogeneous assemblages. Some names which were found to have been preoccupied in other groups have been replaced by new ones. Nearly all the names enumerated have been made public, some of them many years ago, others by Dr. Carpenter in his "Table of Regular Chitons," distributed in November, 1873, but of which a large proportion of the copies printed are still on hand. Some appeared in different papers on mollusca of the northwest coast of North America, published by Dr. Carpenter from 1863 to 1874, and several were elucidated in a paper on the New England chitons in the Bulletin of the Essex Institute in 1873. A majority of them were also characterized by me (partly from Dr. Carpenter's manuscript) in my Report on the Limpets and Chitons of Alaska, &c., Proc. U. S. National Museum, December, 1878. Such as still remained unpublished are now included in the following analytical tables with additional notes elucidating their characters more fully.

It is believed that the publication of these tables will be beneficial in several ways, as in giving a general view of Dr. Carpenter's classification, and especially in calling attention to the characters which it is desirable should be distinctly noted by those who may describe new species of *Chitonida*, and for the want of which it is impracticable, in the majority of cases, to properly classify or even to subsequently recognize the species. The technical terms used and the relations of the several parts have been explained in my report above mentioned, and it is not considered necessary here to repeat the explanations.

The publication of the entire monograph only awaits the preparation of the illustrations, which has been delayed by circumstances entirely beyond the writer's control.

It may be thought by some who have not investigated the subject that the group has been unduly divided. In regard to the permanent

relations of its various genera, no dogmatism is justifiable at present or until the characters of a much larger number of species have been definitely determined. Until then, when the questions can be decided, the various subdivisions will at least serve a very useful purpose in calling attention to differences which otherwise might pass unnoticed or unheeded. For my own part, my impressions are that the majority of the genera or subgenera proposed by Dr. Carpenter will eventually be recognized as well founded, though a certain number may be condemned to consolidation.

## NOTES ON THE GENERA.

6. *Cymatodus* Carpenter, MS., not of Newberry, 1870.

7a. Differs from *Leptochiton* not only in its hairy girdle, but also in its valves, which are thrown forward, forming a decided transition toward some of the palæozoic forms. Type *Leptochiton curvatus* Cpr. Okosiri, Japan; A. Adams.

10. *Microplax* Adams and Angas 1864, not of Lilljeborg, 1865.

12. *Callochiton* (restricted). Laminae broken up into very numerous teeth rising out of spongy eaves, and having a tendency to become propped outside; sinus a mere wave in the united bodies of the sutural laminae; mantle reticulated with peculiar bodies, the tips of which appear like diamond-shaped scales, and which are unlike the girdle-armature of any other Chiton. Example *Chiton larvis* of Montague, Pennant and Gray.

12a. Subgenus *Stereochiton*; *Callochiton*: zona coriacea sparsim lanuginosa. Type *Chiton castaneus* Wood, Ind. Test. et Gen. Couch.

15. Valvæ tenues in zona tenui, levi, partim immersæ; laminae insertionis acutæ, terminales pauci-fissatæ, sed regulares; sinus haud dentatus; mucro medianus. Example, *Chiton coarctatus* Sowerby, Isle of Bohol.

17. Valvæ partim immersæ; laminae acutæ, Ischnoidæ; sinus magnus levis; mucro medius planatus; zona spongiosa, antice producta. Example, *Spongiochiton productus* Cpr., New Zealand, Mus. Cuming, no. 50. This may be considered a partially covered *Chætopleura*, just as *Leptoplax* is a partially covered *Tonicella*.

20. Testa extus et intus ut in *Callistochitone*, zona porifera aliter nuda. Type *Chiton retusus* Sby. China Seas.

21. Testa extus et intus Chætopleuroidea sed subgrundis parvis; zona minutæ squamulopilosa, fasciulis ad suturas instructa. (= *Hanleyia* Ad. & Angas, non Gray). Type *A. tetrica* Cpr. Ceylon. Mus. Cuming, no. 83.

*Hanleia variabilis* Ad. and Angas probably belongs to this group, but has not been dissected.

23. *Ceratophorus* Carpenter MS. (non Diesing, 1850). Valvæ extus et intus Chætopleuræ similis, sed dentibus suffultis, subgrundis curtis; zona levis, in cornua seu cornuum fasciulas circa suturas et marginem porrecta. Type *Chiton Guildingi* Reeve.



This differs from all other hairy or spiny Chitons, at all nearly related to it, in the mantle ornaments not being inserted into sockets, but being extensions of its substance.

24. (*Hemphillia* Cpr. MS., non Binney.) *Nuttallina*: zona lanugosa; laminae centrales unilissatae. This section unites in a form resembling *Nuttallina* some of the features of *Middendorffia*, from which the girdle differs in being spongy and covered with soft hairs instead of short shelly bristles. The shape is that of an *Ischnochiton*, the sculpture and girdle of *Chatopleura*, the insertion plates and sinus almost exactly like *Middendorffia*. Type *Pallochiton lanuginosus* Cpr. sp. Lower California.

26a. *Fannia* Gray, not Robineau Desvoidy, 1830.

29. Lorica Acanthopleura, zona Enoplochitoni similis; laminae obtusae, pectinatae, sinus undatus, levis. Type *Scleorchiton* Cpr. Torres Straits. Mus. Cuming, no. 42.

Most like *Enoplochiton*, from which it differs in the articulation of the tail plate and the sub-central mucro.

30a. *Lucia* Gould, not of Swainson, 1833.

30c. Acanthopleura: valvis partim immersis, planatis; laminis centralibus pleurifissatis; sinu lobato. Type *Chiton spinosa* Brugiere.

This form bears the same relation to *Acanthopleura* that *Fannettia* does to *Tonicia*, with the additional peculiarity of Radsoid nicks in the central valves. Named for Dr. Francis, once editor of the *Annals and Magazine of Natural History*.

31. Lorica solidissima alata: mucro haud elevatus submedianus; laminae valvae separatae, acutae, leves; V. post. antice tendentes; sinus minimus; zona coriacea, fasciculatim spinulosa. Type *Chiton gigas* Chemnitz.

32. (*Dawsonia* Cpr. (preœ.) 1873; *Middendorffia* Cpr. in MS. later.) Lorica et zona extus ut in *Acanthopleura*; laminae acutae, extus rugosa, suffultae; sinus planatus haud laminatus. Type *Chiton Polii* Philippi (non Deshayes), Dalmatia. Internally Ischnoid, externally Acanthopleuroid.

32a. (*Beania* Carpenter, not Johnstone.) Lorica et zona inter Acanthopleuram et Ischnochitonem intermedia; mucro submedianus; laminae acuti, haud suffulti; zona squamis subspinosis striatis vix imbricata. Type *Chiton Rissoi* Cuming, non Payr. *C. pseudorissoi* Cpr. MS., Malta. Mus. Cuming, no. 51.

34. Lorica tenuis; valvae undatae; mucro posticus, productus, laminae acutae, leves; V. post. antice projectae, sinus planatus, laminatus, levis; zona coriacea, levis, seu lanugata. Type *Arthuria filosa* Cpr., loc. incert. Mus. Cuming, nos. 23, 38.

This has the aspect of *Chatopleura* externally in sculpture, but has the tail plate like *Nuttallina* in its structure, and like *Placiphora* in its external appearance.

36a. *Aulacochiton* pars, Shuttleworth, 1853. Lorica: mucrone postico, parum sinuato; sinu lobato; zona squamulis minimis obsita, antice producta. Example, *Lorica Angasi* H. Adams, P. Z. S., 1864, p. 193. Australia.

- 40a. = *Streptochiton* Cpr. MS. Type *F. Collei* H. Adams. Australia.  
 40b. Placiphora: sinu lato, planato; zonæ setis haud fasciculatim instructis. Type *Chiton petholatus* Sowerby. South Australia.  
 40c. Placiphora: valvis partim immersis; zona postice emarginata. Type *G. obtecta* Cpr. New Zealand. Mus. Cuming, no. 45.  
 43a. *Acanthochiton*: valvis partim tectis; mucrone Ischnoideo; lam. postica rugosim lobata; ar. lat. depressis. Type *M. plumeus* Cpr. Hab.? Mus. Cuming, no. 108.  
 43b. *Acanthochiton*: valvis per duas trientes immersis. Type *S. porrecta* Cpr. Japan. Mus. Cuming, no. 97.

49. Animal repens, satis elongatum: valvæ expositæ parvæ, omnino contiguæ; valva postica infundibuliformis; mucro retrojectus, terminalis; laminae ut in *Katherina* sed obsoletim fissatæ; zona *Acanthochitonoidea*. Type *Chiton strigatus* Sowerby. West Indies.

49a. Animal et testa *Choneplacis* similes sed zona haud porifera. Based on *Chitonellus striatus* and *strigatus* Sowerby, Conch. Ill., figs. 62 and 63, which are represented as without pores. In the former the valves are separated (as in *Notoplax*); in the latter they touch (as in *Choneplax*). The species need examination to confirm the accuracy of the figures, but it is probable that there are both pore-bearing and non-poriferous species among the vermiform as well as the compact *Chitonelles*. These last groups are the highest and most active in the whole order in tropical waters, as is *Cryptochiton* in the north.

TABLE I.

The following table will exhibit the minor characteristics of most of the recent Chitons in regard to the plan of the insertion plates, number of slits, if any, in anterior, middle and posterior valves; character of the tooth-like projections between the slits; and of the margin of the outer layer overhanging the insertion plates, termed *eaves* by Dr. Carpenter; all according to the numbers and letters of the preceding list:

× = many: + = few: - or more: \* = irregular.

No. of genus.	Plan of insertion plates.	Slits in valves.			Teeth.	Eaves.	Gills.
		Posterior.	Anterior.	Middle.			
<i>(Leptoidea.)</i>							
7	None .....	0	0	0	None .....	None .....	Short.
7a	do .....	0	0	0	None .....	None .....	Post.
8	Only in anterior valve.....	0	0	0	Rugose lamina .....	Minute .....	(?)
9	Present in anterior and posterior valves.....	0	0	0	Smooth lamina .....	do .....	Short.
10	Present in all valves.....	0	0	0	do .....	None .....	Short.
<i>(Ischnoidea.)</i>							
11	Regular, branching .....	×	×	1	Sharp, normal .....	Projecting, spongy.....	Med.
11a	do .....	×	×	2+	do .....	do .....	Med.
12	Minutely divided.....	×	×	2+	Propped outside .....	Broad, spongy.....	(?)
12a	do .....	×	×	5+	do .....	do .....	(?)
13	Regular, branching .....	×	×	1	Sharp, normal .....	Short .....	Med.
14	do .....	11	11	1	do .....	do .....	Subamb.
15	Regular, projecting .....	6	4	1	Sharp, long, thin .....	Minute.....	(?)
16	Regular, branching .....	×	×	1	Sharp, normal.....	Moderate .....	Amb.

x = many; + = few; + = or more; \* = irregular.

No. of genus.	Plan of insertion plates.	Slits in valve.			Teeth.	Eaves.	Gills.
		Posterior.	Anterior	Middle.			
16a	Regular, branching	x	x	2+	Sharp, normal	Projecting	(?)
17	do	6	5	1	Sharp, long, smooth	Minute	(?)
18a	do	x	x	1	Sharp, normal	Projecting	Amb.
18b	do	x	x	2+	do	do	Amb.
18c	do	8	10	1	do	do	Amb.
18d	do	11	11	1	do	do	Amb.
18e	do	x	x	1	do	do	Amb.
18f	do	x	x	2+	do	Projecting, long	Amb.
18g	do	x	x	1	do	do	Amb.
18h	do	x	x	2+	do	do	Amb.
19	do	x	x	1	Excurred, plumate	do	Amb.
20	do	x	x	1	Excurred, solid	Projecting	(?)
21	do	x	5	1	Rough, propped	Short	(?)
22	do	x	x	1	Solid, not propped	do	(?)
23	do	x	x	1	Solid, propped	do	(?)
24	do	8-10	8-9	1	Sharp, curved	Short, spongy	Med.
<i>(Lophyroidea.)</i>							
25	Regular, branching	x	x	1	Blunt, serrate	Short, spongy	Amb.
25a	do	x	x	2+	do	do	Amb.
26	do	x	x	1	Sharper, serrate	do	Amb.
26a	do	9	9	1	Sharper, serrate, long	Very short	Amb.
27	Unfissured	*x	*x	*x	Blunt, fimbriate	Short	(?)
28	Regular	x	5	1	(?)	(?)	(?)
<i>(Acanthoidea.)</i>							
29	Regular, branching	x	x	1	Blunt, grooved	Projecting, grooved	(?)
30	do	x	x	1	Longer, grooved	do	Amb.
30a	do	x	x	2+	do	do	(?)
30b	do	0	x	1	do	do	Amb.
30c	do	10	15	2+	do	Very short	(?)
31	do	10	10	1	Long, smooth	Moderate, not grooved	(?)
32	do	8	9	1	Propped, smooth	Moderate, spongy	(?)
32a	do	9	9	1	Short, sharp, smooth	Projecting	(?)
33	V. all thrown forward	7-8	10	2	Very long, sharp, smooth	Short	Amb.
34	V. post. thrown forward	9+	10	1	Normal, sharp, smooth	Moderate	(?)
35	do	6+	5	1	Very long, sharp, smooth	Very short	Amb.
<i>(Schizoidea.)</i>							
36	{ Regular, posterior valve {	0	x	1	Blunt, rugose	Moderate	(?)
36a	{ slit between 2 ridges. {	0	x	1	Sharp, serrate	Long	(?)
37	Str. forward, deep slit	+	x	1-2	Sharp, long	Small	Med.
<i>(Placiphoroidea.)</i>							
38	Str. forward, flat behind	0	x	1	None behind	Deeply furrowed	(?)
39	Regular, flat behind	0	x	1	Normal, serrate	Moderate	(?)
40	Regular, ribbed behind	0	x	1	Slightly propped	Small	Amb.
40a	do	0	x	1	Excurred	do	(?)
40b	do	0	x	1	Sharp	Minute	(?)
40c	do	0	x	1	Sharp, very long, smooth	do	(?)
<i>(Mopaloidea.)</i>							
41	{ Regular, posterior valve {	1	8+	1	Long, propped	Minute	Med.
41a	{ laminated. {	1	x	1	Mod., simple	Small	(?)
42	Thrown forward, laminated	*x	7	1	Very long, propped	Minute, spongy	Amb.
43	do	1	5	1	Long, sharp, smooth	Small	Med.
43a	Thrown forward somewhat	*x	5	1	Very long, sharp, smooth	Minute	(?)
43b	Thrown forward much	1	5	1	Very long, sharp, rugose	do	(?)
44	Tail plate crenate behind	2	5	1	Crenate, sharp, smooth	do	Long.
<i>(Cryptoidea.)</i>							
45	Regular, behind variable	*x	5	1	Very long, smooth	Minute	Med.
46a	Mopaloïd	2	6	1	do	do	Amb.
46b	do	2	5	1	do	do	Amb.
47	Coarsely mopaloïd	2	5	1	do	None	Amb.
<i>(Chitonelloidea.)</i>							
48	Very sagittate	0	5	0-1	{ Very short, except {	Distinct	Post.
48a	do	0	5	0	{ at sutures. {	do	Post.
49	Intermediate	1	5	1	Mod. long in front	Minute	(?)

TABLE II.

This table enumerates in brief the characters of the sinuses of the girdle and its armature, and the chief distinctive peculiarities of each group.

No. of genera.	Sinus.	Girdle.	Peculiarities.
7	Simple, smooth, deep	Gravelly scales, smooth or striated	All negative.
7a	Simple, broad	Spicules and chaffy scales	Flattened mucro, valves thrown forward
8	Simple, broad, shallow	With hairs or fine spines	Laminae only on anterior valve.
9	Broad, spongy	Solid, downy, poriferous	Terminal valves laminated.
10	Obsolete	Thin, horny, finely granulous	Unslit laminae on all valves.
11	Broad, shallow	Granular flattish scales	Short gills, granular scales.
11a	do	do	Radsioid central slits.
12	Extremely small	Long, horny scales	Small sinus, reticulate girdle, crowded propped teeth.
12a	Most minute	Smooth, downy	Smooth girdle.
13	Broad, shallow	Smooth or downy	Short gills, ischnoid plates.
14	Broad, fissured	Smooth	Valves slit in dorsal axis.
15	Moderate	Thin, smooth	Teeth few, valves partly immersed.
16	Broad or minute	Hairy	Ischnoid plates, hairy girdle.
16a	Broad, smooth	Short, striated, shelly bristles	Radsioid slits ischnoid plates, striated bristles.
17	Simple, broad, deep	Spongy, downy	Half immersed valves, plates ischnoid.
18a	do	Irregular, chaffy scales	Body long, chaffy scales.
18b	do	do	Same as last, with radsioid slits.
18c	Simple, narrow, deep	Long, striated spines and scales	Same, triple series of striated scales.
18d	Simple, broad, shallow	Double series scales, not chaffy	Body normal, double series of scales.
18e	do	Small, transverse scales	Body normal, small striate scales.
18f	do	do	Body normal, radsioid slits.
18g	{ Broad, shallow, some- times dentate. }	Large, smooth, imbricated scales.	{ Scales of <i>Chiton</i> , plates of <i>Ischno- chiton</i> .
18h	{	{	{
19	Broad, shallow, laminate	Narrow, with small scales	Narrow girdle, highly sculptured, plates curved outward.
20	Narrow, deep, laminate	Smooth, with marginal tufts	Curved plates, marginal pores.
21	Narrow, shallow, simple	Minute bristles and sutural hair-tufts.	Propped teeth, sutural pores.
22	Rounded, simple	Fleshy with long, hairy bristles.	Tough fleshy girdle, propped teeth.
23	Narrow, shallow, simple	Smooth, with horny processes	Propped teeth, horny girdle processes.
24	Broad, shallow, simple	Spongy, with scattered soft hairs.	Spongy girdle, single lateral slits.
25	Squared, denticulate	Large, solid, imbricate scales	Broad serrated teeth and sinus, scaly girdle.
25a	do	do	Same, with added side slits.
26	do	Smooth or downy	Sharper teeth, smooth girdle.
26a	do	Smooth, spreading	Sharper teeth, valves partly covered.
27	Small, laminae united	Hairy	Non-fissured but deeply pectinate teeth, hairy girdle.
28	(?)	"Minutissime asperulus"	Posterior valve "medio fimbriata."
29	Large, laminae united	Large, solid, grooved scales	Non-imbricate scales, broad grooved and serrate teeth.
30	Large, waved, laminae united.	Shelly bristles	Teeth short inside, long outside, waved sinus.
30a	do	do	Same, with radsioid slits.
30b	{ Large, waved, lobed, lam- inae united. }	{ Shelly spines	{ Spinous girdle, lobed sinus.
30c	{	{ Shelly bristles, spreading	{ Partly covered valves, radsioid slits.
31	Minute, waved, smooth	Smooth, small, downy tufts	Downy girdle tufts, smooth sharp teeth.
32	Simple, laminae separated.	Granular bristles	Bristly girdle, smooth propped teeth.
32a	do	Bristly, striated scales	Sharp teeth, striate scales.
33	do	Broad, with shelly bristles	Long, sharp teeth, radsioid slits, posterior mucro.
34	Narrow, smooth, laminate	Thin, lanugate	Twisted mucro, smooth, thin girdle, thin ischnoid valves.
35	Narrow, laminae separated	Thin, lanugate, wide, with sutural pores.	Smooth, porous girdle partly covering valves, very long teeth.
36	Narrow	Slit behind, solid smooth scales	Slit tail-plate, scaly girdle.
36a	Narrow, lobed	Produced in front, upright scales	Sharp teeth, produced girdle, bilobed scales, lobed sinus.
37	Narrow, very deep	Slit behind, minute spiculae	Very long and narrow, deep slit.
38	Deep, lobed	Large, separate scales, bristles between.	Scaly girdle, flattened tail-plate.

TABLE II—Continued.

No. of genus.	Sinus.	Girdle.	Peculiarities.
39	Moderate, lobed .....	Chaffy hairs .....	Hairy girdle, glossy valves, flattened tail-plate.
40	Small, sut. laminae joined ..	Hairy, with regular pore-tufts ..	Rows of pore tufts, swollen ribs.
40a	Broad, shallow .....	do .....	Outbending of the teeth.
40b	Broad, deep, spongy .....	Crowded hairs without pores ..	Hairy girdle without pores.
40c	do .....	Encroaching on valves pore-tufts	Valves partly covered.
41	Very narrow .....	Hairy, often slit behind .....	Normal shape, sharp lamina with one slit, waved behind.
41a	do .....	Regular pores, much produced in front.	Same, with small pores.
42	Deep, broad, spongy .....	Smooth, valves nearly covered ..	Smooth, broad girdle, teeth thrown forward.
43	do .....	Hairy, with long, fasciculated spiculae.	Tufted girdle, large lamina, minute tail-plate.
43a	Moderate .....	Smoother, with tufts .....	Valves partly covered, sunken side areas, lobed tail-plate.
43b	Shallow, broad .....	Hairy, with tufts .....	Valves nearly covered, tufted girdle.
44	Deep, narrow .....	Crowded spiculae, with sutural pores.	Valves separated with narrow sinus.
45	Deep, arched .....	Smooth, tufted, valves nearly covered.	Arched, nearly covered valves, tubercular pores near jugum.
46a	Broad .....	Smooth, irregularly tufted .....	Tips of valves only exposed, soft bristles irregularly disposed, short gills.
46b	do .....	Coriaceous, irregularly tufted ..	Same, with ambient gills.
47	Deep .....	Covering the shell, with numerous fine spiculae in tufts all over the surface.	Valves entirely covered.
48	Very deep and narrow .....	Crowded bristles, no tufts .....	Very long, hind valves separate.
48a	do .....	Crowded bristles, with tufts .....	Same, with small tufts.
49	do .....	Gravelly, with sutural tufts .....	Side tufts, valves touching.

With the above data and those comprised in my report on the Limpets and Chitons of Alaska, &c., students should be pretty well able to refer any Cliton of whose characters they have made themselves masters to its proper place in the general classification.

NOVEMBER 30, 1881.